



## HYDROLOGIC RESOURCE MONITORING PARAMETERS

# Streamflow



**Brief Description:** Streamflow varies with the volume of water, precipitation, surface temperature, and other climatic factors. For most streams (rivers), the highest water discharge is found close to the sea, but in arid regions discharge decreases naturally downstream. Land use in drainage basins also strongly affects streamflow. For a given area of  $1 \text{ km}^2$ , the water discharge (specific run-off) may range from  $<0.1 \text{ l/s}$  to  $>50 \text{ l/s}$ . Major streamflow regimes include glacial (ice melt: regular high water period in early summer, with annual mean discharge  $q = 10\text{-}20 \text{ l/s/km}^2$ ); nival (snow melt: late spring high water, with  $q = 3\text{-}15 \text{ l/s/km}^2$ ); pluvial (high water in late autumn-winter, with  $q = 5\text{-}20 \text{ l/s/km}^2$ ); dry tropical (high water in summer rainy season, with  $q = 0.5\text{-}10 \text{ l/s/km}^2$ ); monsoon ( $q = 20\text{-}40 \text{ l/s/km}^2$ ); equatorial (high water during two rainy periods, with  $q = 15\text{-}30 \text{ l/s/km}^2$ ); and desert (non-perennial flow, with  $q <0.5 \text{ l/s/km}^2$ ). Reversals in streamflow, in conjunction with indirect methods of paleoflood studies and paleohydrology, yield long-term indicators of changes in discharge that are valuable for responses to flooding, estimating long-term trends in water and sediment discharges, and for distinguishing possible long-term climate change.

**Significance:** Streamflow directly reflects climatic variation. Stream systems play a key role in the regulation and maintenance of biodiversity. Changes in streams and streamflow are indicators of changes in basin dynamics and land use. One estimate puts the total annual losses to the economy from flooding of river and coastal plains worldwide at US\$20,000 million.

**Environment where Applicable:** Fluvial systems - rivers, streams and channels

**Types of Monitoring Sites:** Stream channels

**Method of Measurement:** There are standard techniques for measuring streamflow. All measurements are based on the continuity equation,  $Q = AV$ , whereas streamflow is typically estimated from channel size using the power relation  $Q = aW^b$  (where  $Q$  = discharge,  $A$  = areal cross-section,  $V$  = velocity,  $a$  = a coefficient,  $W$  = channel width, and  $b$  is an exponent). Where more quantitative data are not available, study of changes in biomass distribution (especially woody plants) can provide reliable qualitative measures of hydrologic and geomorphic events spanning the past several hundred years.

**Frequency of Measurement:** continuous to periodic

**Limitations of Data and Monitoring:** Streams in flood, and on deltas, alluvial plains and karst terrains, are difficult to gauge. The effectiveness of stream flow as an indicator depends strongly on a well-designed, systematic network of monitoring stations. Despite their importance for understanding climate change, assessments of temporal variations in runoff, evaporation and soil water storage have been neglected, in part because of a lack of monitoring efforts.

**Possible Thresholds:** NA

### Key References:

Baker, V.R., R.C.Kochel & P.C.Patton (eds) 1988. Flood geomorphology. New York: John Wiley and Sons.

Osterkamp, W.R. & S.A.Schumm 1996. Geoindicators for river and river-valley monitoring. In Berger, A.R. & W.J.Iams (eds). Geoindicators: Assessing rapid environmental changes in earth systems: 83-100. Rotterdam: A.A. Balkema.

Wolman, W.G. & H.C.Riggs 1990. Surface water hydrology. The Geology of North America, Volume 0-1, Boulder, CO: Geological Society of America.

**Related Environmental and Geological Issues:** Streamflow affects virtually all other environmental issues connected with water. Flooding is a major natural hazard that can result from human activities, as in dam failure. Human-induced fragmentation and regulation of river flow has major implications for the health of riparian ecosystems. There are also many chemical parameters to be taken into account when assessing the state of a river system [see surface water quality].

**Overall Assessment:** Streamflow is of fundamental importance to virtually all environmental monitoring.

**Source:** This summary of monitoring parameters has been adapted from the Geoindicator Checklist developed by the International Union of Geological Sciences through its Commission on Geological Sciences for Environmental Planning. Geoindicators include 27 earth system processes and phenomena that are liable to change in less than a century in magnitude, direction, or rate to an extent that may be significant for environmental sustainability and ecological health. Geoindicators were developed as tools to assist in integrated assessments of natural environments and ecosystems, as well as for state-of-the-environment reporting. Some general references useful for many geoindicators are listed here:

Berger, A.R. & W.J.Iams (eds.) 1996. Geoindicators: assessing rapid environmental change in earth systems. Rotterdam: Balkema. The scientific and policy background to geoindicators, including the first formal publication of the geoindicator checklist.

Goudie, A. 1990. Geomorphological techniques. Second Edition. London: Allen & Unwin. A comprehensive review of techniques that have been employed in studies of drainage basins, rivers, hillslopes, glaciers and other landforms.

Gregory, K.J. & D.E.Walling (eds) 1987. Human activity and environmental processes. New York: John Wiley. Precipitation; hydrological, coastal and ocean processes; lacustrine systems; slopes and weathering; river channels; permafrost; land subsidence; soil profiles, erosion and conservation; impacts on vegetation and animals; desertification.

Nuhfer, E.B., R.J.Proctor & P.H.Moser 1993. The citizens' guide to geologic hazards. American Institute for Professional Geologists (7828 Vance Drive, Ste 103, Arvada CO 80003, USA). A very useful summary of a wide range of natural hazards.